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(54) PROCESS FOR CONVERTING SEWAGE SLUDGE INTO COMPOST

(71) I, FRANZ KNEER, a German Citizen of 6450 Hanau—Mittelbuchen, Am Schwaberg 19, Federal Republic of Germany, do hereby declare that the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a process for converting sewage sludge into compost by biological decomposition.

In the treatment of sewage sludge, which initially contains 90—95% of water, it is usual to begin by removing a large part of the water by means of a thickener, a filter or centrifuges. The resulting thickened sludge is then usually stored in either open or closed decomposition chambers, with the release of methane.

This method is however time-consuming and cumbersome, the necessary plant occupying a great deal of space. A further disadvantage of the known method is that the processed sludge, that is to say decomposed sludge can have only a limited application as an agricultural fertiliser, due to the fact that the material is unreliably sanitized under the anaerobic conditions of the process.

It is also known to add a certain fraction of other organic wastes to the sludge, for the purpose of forming compost by decomposition. But even this method is capable of disposing of only a comparatively small quantity of sludge and it is still necessary to get rid of the remainder by dumping.

The aim in at least the preferred embodiments of the present invention is to provide a process for converting sewage sludge directly into a fully utilisable compost.

According to the present invention there is provided a process for converting sewage sludge into compost by biological decomposition, including the steps of feeding sewage sludge and an organic additive (as hereinafter defined) into the upper part of a rector, and feeding air and additional oxygen, for the biological decomposition, into the lower part of the reactor so that the sewage sludge and the gases flow countercurrent to each other, the air and additional oxygen being fed to the reactor at a rate such that zones of different temperatures and different oxygen concentrations prevail at different locations in the reactor, the highest temperature being in the upper part of the reactor, the lowest temperature in the bottom part, the highest O_2 concentration being near the bottom of the reactor and the lowest near the top.

The ratio of carbon/nitrogen in raw sewage sludge is normally too low for the sludge to ever start to decompose into compost. The organic additive is accordingly added to raise the carbon/nitrogen ratio to a level at which such decomposition can occur. Suitable additives comprise for example, peat and/or sawdust and/or straw and/or processed sewage sludge. These examples are not however exhaustive and the term "organic additive" as used herein is to be construed as embracing any organic substance which can be added to sewage sludge to raise the carbon/nitrogen ratio to a level at which the sludge will decompose into compost.

A problem involved is that raw sewage sludge contains a comparatively high concentration of Na ions and heavy metal ions. If a fertilizer is made of the sludge these ions re-enter the biological circuit, accumulating in vegetable and animal organisms. It is therefore a further aim of more preferred embodiments of the present invention to reduce the sodium fraction and the concentration of heavy metal ions in the produce compost.

This problem is solved, according to the

invention, by adding bentonite flour to the sludge.

Preferably about 7.5—12.5 kg of bentonite flour is added, per m^3 of sludge.

Bentonite is a special kind of clay which has a high swelling and absorption capability. The main constituent is the mineral montmorillonite. Bentonite has the property of substituting, by ion exchange, Ca ions which are chemically bound in the bentonite for the Na and heavy metal ions in the sewage sludge. These ions reach the sewage through the sewers, for example from salt strewn onto the roads.

Bentonite also contains silicon compounds which form, with the sodium in the sludge, complex compounds which are insoluble in water. The same thing applies to the heavy metal ions. The addition of benetonite flour to the sludge before charging to the aeration reactor therefore has the result that the product compost leaving the reactor has a tolerably low concentration of Na and heavy metal ions. The product compost contains clay-humus complexes which add to the soil, in addition to the main nutrients and trace-nutrients, also a variety of organic compounds and micro-organisms which help to restore the biological balance in the soil. The clay-humus complexes also store moisture due to the swelling property of the montmorillonite crystals, giving the soil a good crumbly structure.

Enriching the aeration air with extra oxygen promotes the growth of a variety of air-consuming bacteria, the resulting decomposition being therefore a fully aerobic process. The bentonite reduces the concentration of sodium and heavy metal ions in the product compost down to a tolerable value.

In the preferred process hereinafter described with reference to the drawings, the mixture comprising thickened sewage sludge together with organic additive and bentonite flour, moves continuously downwards through the reactor and air mixed with oxygen flows continuously upwards through the mixture. The mixture therefore moves in countercurrent to the gases. The body of material in the reactor contains different zones where the temperatures and the O_2 concentrations are different. The locations of the zones are controllable to a certain extent by adjusting the feed of the air enriched with oxygen. The different zones are inhabited by different species of micro-organisms. The biological decomposition therefore takes place in a succession of stages in the different zones or layers, optimising the biological decomposition process. The biological activities in the different zones can be followed by measuring the temperatures and the O_2 or CO_2 concentrations, and controlled within limits by adjusting the feeds of air and oxygen. In the upper third of the reactor a heat-trap zone is formed where the temperature is 70—80°C. By adjusting the air and oxygen feed rates it is possible to retain this heat-trap zone fairly precisely in a desired upper fraction of the reactor. The material charged into the reactor at the top, must necessarily pass through the heat-trap zone, with the result that substantially all pathogenic micro-organisms in the sludge are killed, intensively sanitizing the material.

The mixture, which can if desired be seeded with suitable bacteria, is charged to the reactor from the top and moves downwards slowly, taking 14—20 days to reach the bottom. In this movement the material passes through the different temperature and O_2 concentration zones. Each particular species of micro-organism concentrates itself in the zone where the conditions are most favourable for its propagation. The process which is operated as a continuous process, substantially completely decomposes and sanitizes the sewage sludge, producing a utilisable compost containing a considerably reduced concentration of sodium and heavy metal ions.

The volume of additional oxygen entering the reactor preferably composes 5 to 20% of the total volume of gas fed to the reactor.

The air enriched with oxygen is preferably fed to the body of material by a blower, preferably through a system of small-diameter nozzles.

Gas samples are preferably taken at three different locations in the body of the material. The O_2 or CO_2 concentrations in the samples are measured and on this basis the feed rates of air and oxygen are adjusted. The O_2 or CO_2 concentrations at the different zones in the reactor can be shown on recording instruments.

Temperatures are also measured at several, preferably six locations in the body of the material, for controlling the biological decomposition process. The temperatures can also be shown by recording instruments.

The moisture in the material is adjusted by spraying water onto its upper surface in the reactor.

A schematic vertical cross-section through one embodiment of an apparatus in which a process according to the invention can be carried out is shown in the accompanying drawing.

Referring to the drawing, the apparatus comprises a heat-insulated aeration reactor 1 equipped with a feeding device 2 through which raw material is continuously fed.

The raw material comprises sewage sludge mixed with an organic additive and bentonite flour. The organic additive can, for example be peat, sawdust, straw or processed sewage sludge. Approximately 7.5 to 12.5 kg of bentonite flour is used per m^3

of sludge entering the re[actor], the bentonite flour being mixed with the sludge, together with the organic additive, to form the feed mixture. The product is removed from the bottom of the reactor by a delivery device 3, for further processing in a known way.

When the reactor is in operation the body of material moves gradually downwards, as indicated by the arrow 4, the material passing through a series of zones at different temperatures and different O_2 concentrations, the different zones resulting from the activities of the micro-organisms.

Atmospheric air containing added oxygen is blown upwards through the material by a blower 5, the oxygen being conveniently taken from container 25. The air, enriched with oxygen, is blown through a system 6 of small-diameter nozzles into the bottom of the reactor so that the gases rise through the material as indicated by the arrow 8, the process taking place in counter-current flow.

The desired amount of moisture can be added to the material in the reactor by spraying water through a system of spray nozzles 10.

Gas probes 11, 12, 13 are provided for taking gas samples at three different points in the material. A recorder 14 shows the O_2 or CO_2 concentrations at these points. Temperature probes 15—20 serve a further recorder 21 for showing the temperatures at different locations in the body of material. When the reactor is in operation the feed rates of air and oxygen are adjusted on the basis of the indicated temperatures and gas concentrations.

The mixture is fed to the reactor continuously, the reactor remaining quite full all the time. Product is removed continuously from the bottom of the reactor at a rate such that the reactor always remains entirely full.

The air and oxygen are also fed continuously, the material and the gases moving continuously, without interruption, in countercurrent flow, the process being operated as a continuous process.

The process described with reference to the drawings makes it possible for the first time to convert sewage sludge on a large scale into a useful compost.

It should be observed that the entire biological decomposition process can be controlled, within limits, by adjusting the feed rates of air and oxygen, thus influencing the temperatures and gas compositions in the different decomposition zones, which can in this way be shifted up and down in the reactor to a certain extent. The decomposition can also be controlled by varying the flow rate of sewage sludge to the reactor although it is preferred to vary the feed rates of air and oxygen as indicated above.

Although it is preferable to mix the air and oxygen before bl[owin]g them into the reactor it would, of course, be possible to have separate feeds, one for air and the other for oxygen.

Similarly, although it is highly desirable to mix the organic additives and the bentonite flour to the sewage sludge before feeding it into the reactor, it would be possible to add these to the sewage sludge in the reactor.

WHAT WE CLAIM IS:—

1. A process for converting sewage sludge into compost by biological decomposition, including the steps of feeding sewage sludge and an organic additive (as hereinbefore defined) into the upper part of a reactor, and feeding air and additional oxygen, for the biological decomposition, into the lower part of the reactor so that the sewage sludge and the gases flow countercurrent to each other, the air and additional oxygen being fed to the reactor at a rate such that zones of different temperatures and different oxygen concentrations prevail at different locations in the reactor, the highest temperature being in the upper part of the reactor, the lowest temperature in the bottom part, the highest O_2 concentration being near the bottom of the reactor and the lowest near the top.

2. A process according to Claim 1, wherein the organic additive comprises peat and/or sawdust and/or straw and/or processed sewage sludge.

3. A process according to Claim 1 or 2, wherein the volume of additional oxygen entering the reactor comprises 5 to 20% of the total volume of gas fed to the reactor.

4. A process according to Claim 1, 2 or 3, wherein the air and additional oxygen is fed to the reactor by a blower.

5. A process according to Claim 1, 2, 3, or 4, wherein the air and additional oxygen is fed to the reactor through a system of small-diameter nozzles.

6. A process according to any preceding claim, including the step of mixing the air and additional oxygen prior to feeding them into the reactor.

7. A process according to any preceding claim, including the steps of sampling the gas at different locations in the reactor, determining the O_2 or CO_2 concentrations of these samples, and, if necessary, adjusting the feed rates of sewage sludge and/or air and additional oxygen to maintain the O_2 or CO_2 concentrations at those locations in their desired ranges.

8. A process according to any preceding claim, including the steps of measuring the temperature at different locations in the reactor, and, if necessary, adjusting the feed rates of sewage sludge and/or air and additional oxygen to maintain the temperatures at those locations within desired ranges.

9. A process according to any preceding claim, including the step of sprinkling water onto the upper surface of the body of material in the reactor to maintain the moisture content of the material within a predetermined range.

10. A process according to any preceding claims, including the step of adding bentonite flour to the raw sludge.

11. A process according to Claim 10, wherein 7.5 to 12.5 kg of bentonite flour is added, per m^3 of sludge entering the reactor.

12. A process for converting sewage sludge into compost by biological decomposition substantially as hereinbefore described with reference to the accompanying drawing.

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1401566 COMPLETE SPECIFICATION

1 SHEET This drawing is a reproduction of the Original on a reduced scale